XWAY™ PHY

Ethernet Physical Layer Devices

Ethernet Interface Circuit Design

for
XWAY™ PHY11G (PEF 7071), Version 1.3/1.4/1.5

Application Note

Revision 1.4, 2014-02-10

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Page	Subjects (major changes since last revision)
9	**Figure 2**, **Configuration of Single-Port RJ45 Connector for TPI**: Split the transformer and connector in the schematic diagram.
15	**Table 1**, **Bill of Materials**: Updated the components used based on credit-card sized demo board schematic diagram and updated the manufacturer.
17	**Table 2**, **List of Recommended Transformers**: Moved the details of Wurth Elektronik GmbH & Co. KG. to first row.

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1 Overview

This application note describes the circuitry and minimum components required to configure a functional Ethernet PHY port using the Lantiq XWAY™ PHY11G (PEF 7071) Single Port Gigabit Ethernet PHY (10/100/1000 Mbit/s). Of the many schematic choices and interface configurations that can be build using this device, this document shows only a copper application where the MAC interface is RGMII.

For other possible application interface choices please refer to the corresponding User's Manuals **[1]**, **[2]** and **[3]**.

Attention: The application note is not valid for the XWAY™ PHY11G (PEF 7072) device.

2 Ethernet Port Configuration Circuit

Figure 1 shows an overall schematic for configuration of an Ethernet PHY port using the XWAY™ PHY11G.

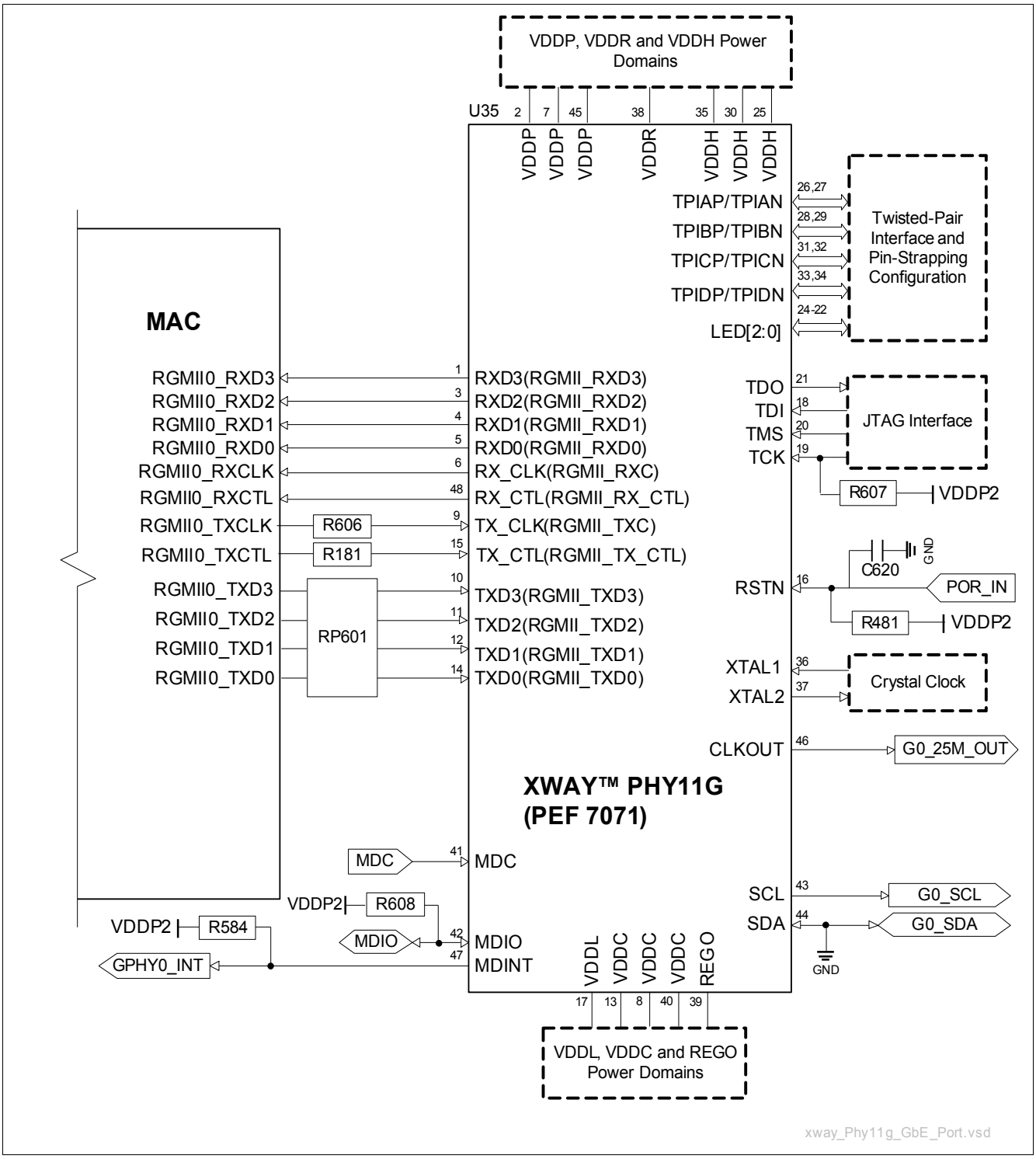

Figure 1 Configuration of Ethernet PHY Port with XWAY™ PHY11G

In **Figure 1**, the following points are to be taken into consideration:

- The circuitry for connecting a single-port connector to the TPI is described in **Chapter 3.1**.
- In this application note, RGMII mode is chosen to connect to the MAC. The pin-strapping configuration for selecting this mode is shown in **Chapter 3.2**.
- The components needed for provision of power domains is described in **Chapter 3.3**, including the option to use the XWAY™ PHY11G's internal DC/DC switching regulator or not.
- The circuitry for connecting a 25 MHz crystal clock source is described in **Chapter 3.4**.
- The MDIO pins (MDIO, MDC, and MDINT) need to be driven with a compliant device.
- The JTAG pins of the XWAY™ PHY11G (TDO, TDI, TMS, and TCK) are not functionally required, but can be connected to a header for test/boundary scan purposes, if required. The JTAG interface is deactivated in this schematic by pulling up the TCK pin.
- Interrupt is configured as active low.
- The I^2C interface is meant for connecting to an external EEPROM. However, it is unused in this schematic. This is indicated by tying the SDA pin to ground.
- **Figure 3** shows the pin-strapping configuration for choosing the following options:
  - RGMII mode to connect to the MAC
  - MDIO address = 0
  - Copper flow
  - During auto-negotiation, advertise 10/100/1000 Mbit/s in both full and half duplex.
  - RGMII Transmit timing skew is set to 1.5 ns.

3 Circuit Block Details

This chapter gives more details on the implementation of circuit blocks shown in the overall schematic in **Figure 1**.

In particular, it covers the following aspects of configuring the XWAY™ PHY11G (PEF 7071) as a single Ethernet port:

- **Twisted-Pair Interface via RJ45 Connector**
- **Pin-Strapping Configuration**
- **Power Supply Domains**
- **Crystal Clock Source**

3.1 Twisted-Pair Interface via RJ45 Connector

Figure 2 shows the circuitry for connecting the TPI pins of the XWAY™ PHY11G to a single-port Gigabit Ethernet RJ45 connector module of type JK0-0193NL, manufactured by Pulse Electronics. This particular type of integrated connector module includes the required transformer circuitry as well. Calibration resistors are required to be connected between the wires of twisted-pair port C and ground. These should be placed nearby XWAY™ PHY11G device and must have 1 % accuracy. LEDs connected to the LED[2..0] pins can display information on the status of the ethernet connection like speed, operating mode, etc.

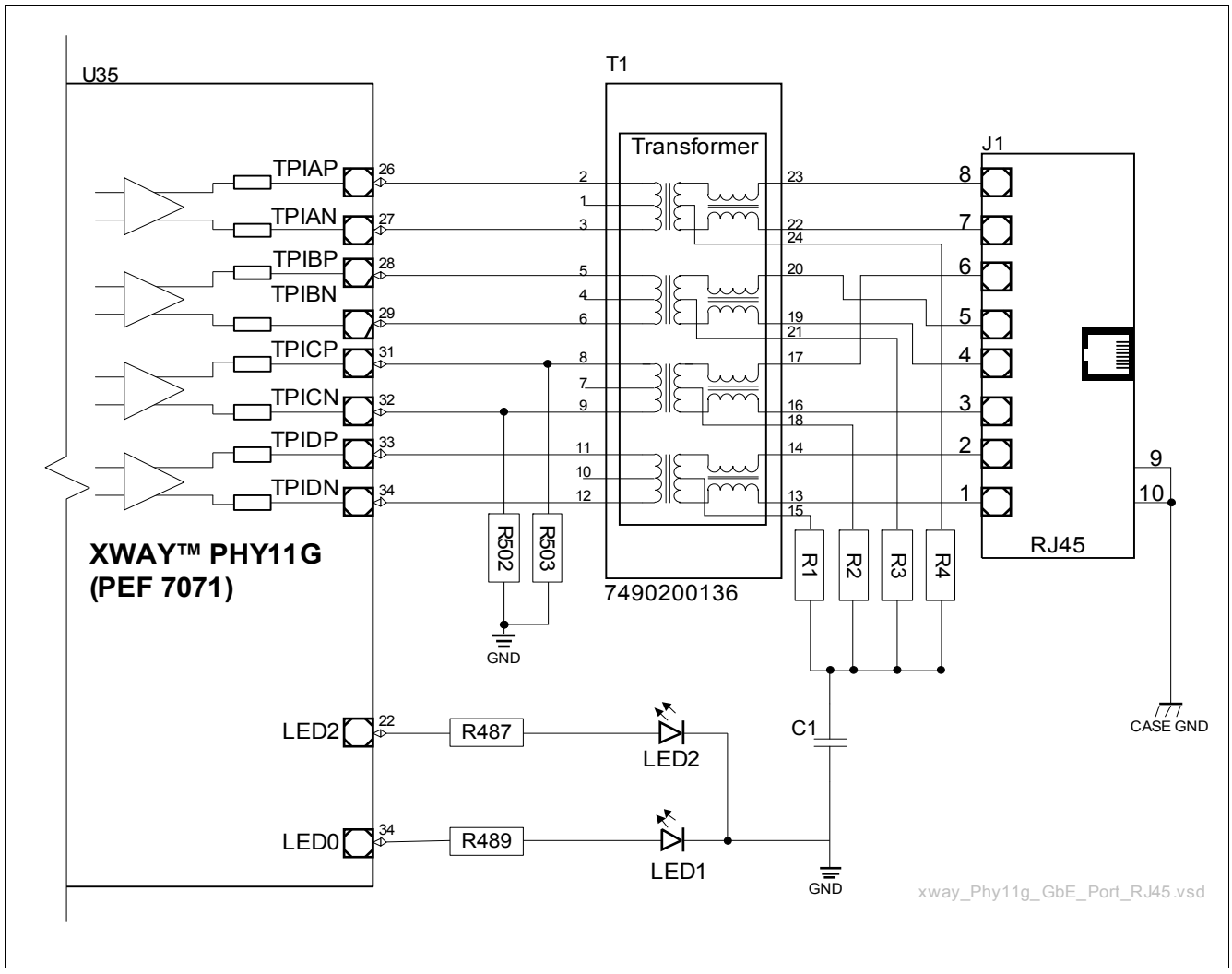

Figure 2 Configuration of Single-Port RJ45 Connector for TPI

Note:

1. *The requirement to leave the center taps of the transformer on the chip side floating, as well as unconnected to each other, must be followed.*
2. *However, for improving EMI performance of the system, center taps of the transformers can be grounded with capacitors with value not exceeding 68 pF.*
3. *The 16 kΩ high precision (1 % accuracy) calibration resistors are required on the line side independent of whether the C and D pairs are being used or not in the application for ethernet connectivity.*

3.2 Pin-Strapping Configuration

The soft pin-strapping configuration is done by means of resistors and capacitors connected to the LED[2:0] pins of the XWAY™ PHY11G. The values of these resistors and capacitors are used to determine the different setup values for different modes of operation. For the scope of this application note, the soft pin-strapping configuration selects RGMII mode to connect the XWAY™ PHY11G to the MAC device. For a list of all possible pin-strapping choices, and their implications, refer to the User's Manuals **[1]**, **[2]** and **[3]**.

Figure 3 shows the soft pin-strapping configuration for RGMII mode. In this configuration, all the vectors on the LED[2:0] pins are set to 000_B.

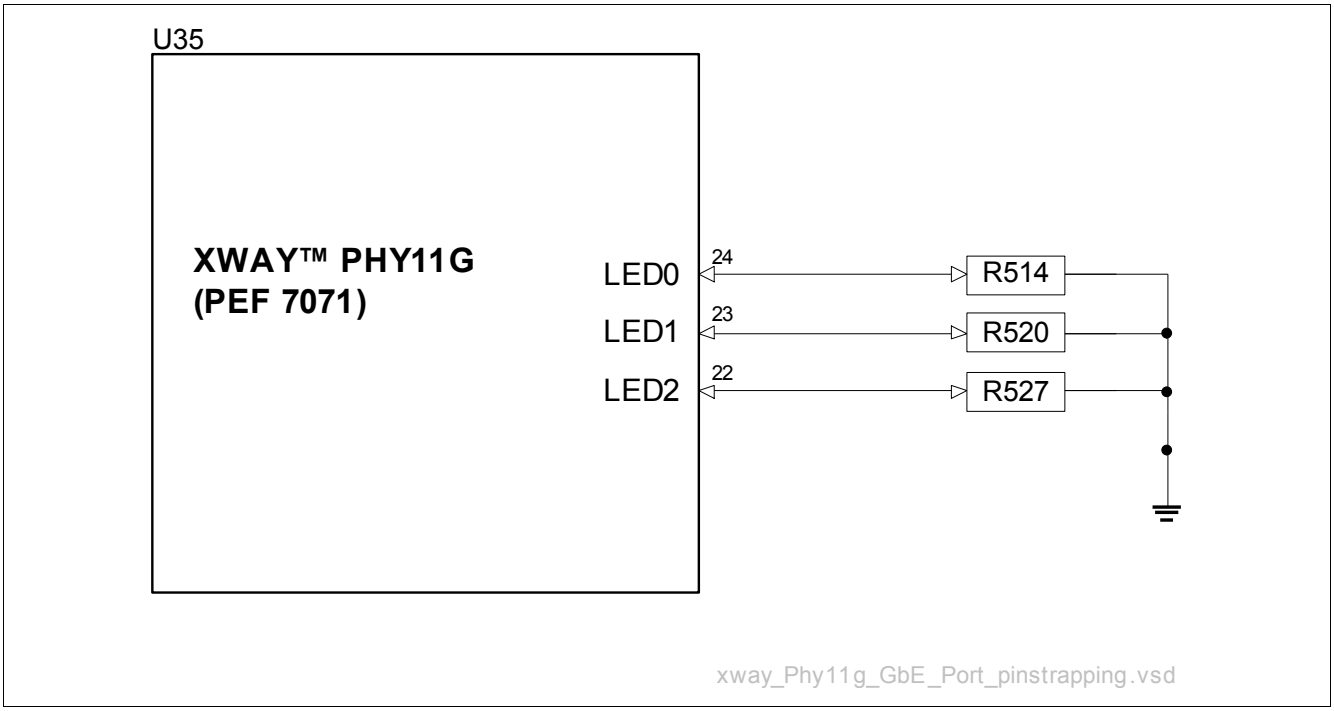

Figure 3 Use of Pin-Strapping Configuration to select RGMII Mode

For details on the value and type of components required for soft pin-strapping configuration, refer to the **Bill of Materials**. The values mentioned there (11 kΩ) are for the configuration chosen for this implementation, for other configurations options, please refer to the User's Manuals **[1]**, **[2]** and **[3]**.

3.3 Power Supply Domains

Figure 4 shows the capacitor components required at the V_{DDP}, V_{DDR} and V_{DDH} power supply inputs.

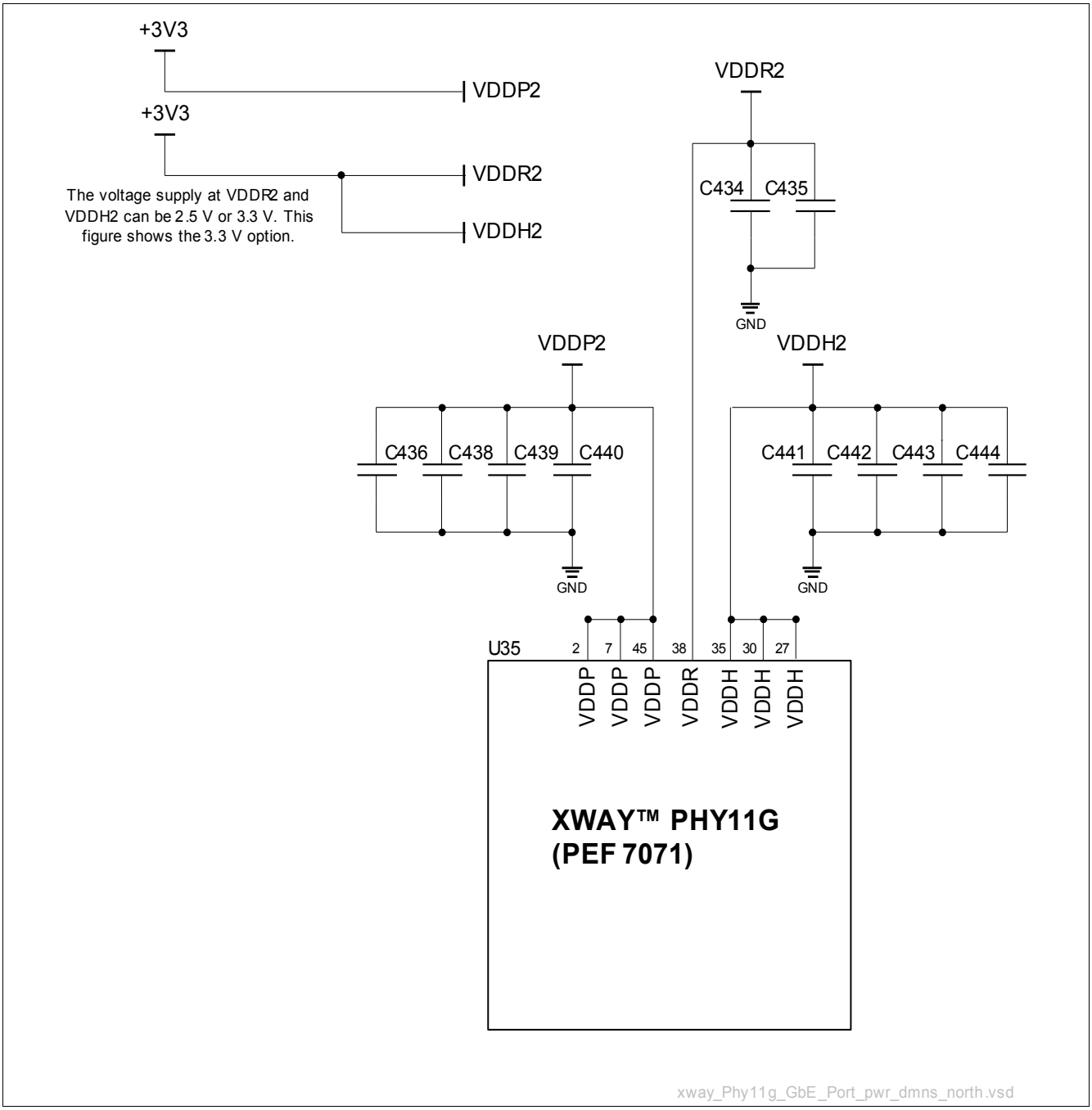

Figure 4 Provision of V_{DDP}, V_{DDR} and V_{DDH} Power Domains

The XWAY™ PHY11G includes an internal DC/DC switching regulator for providing the V_{DDC} and V_{DDL} domains with 1.0 V. However, it also provides the option to disable this switching regulator and provide these domains using an external 1.0 V source.

Figure 5 shows the circuitry required when the internal DC/DC switching regulator is used. Components R586, C494, L10, C479, and C493 are required for this option.

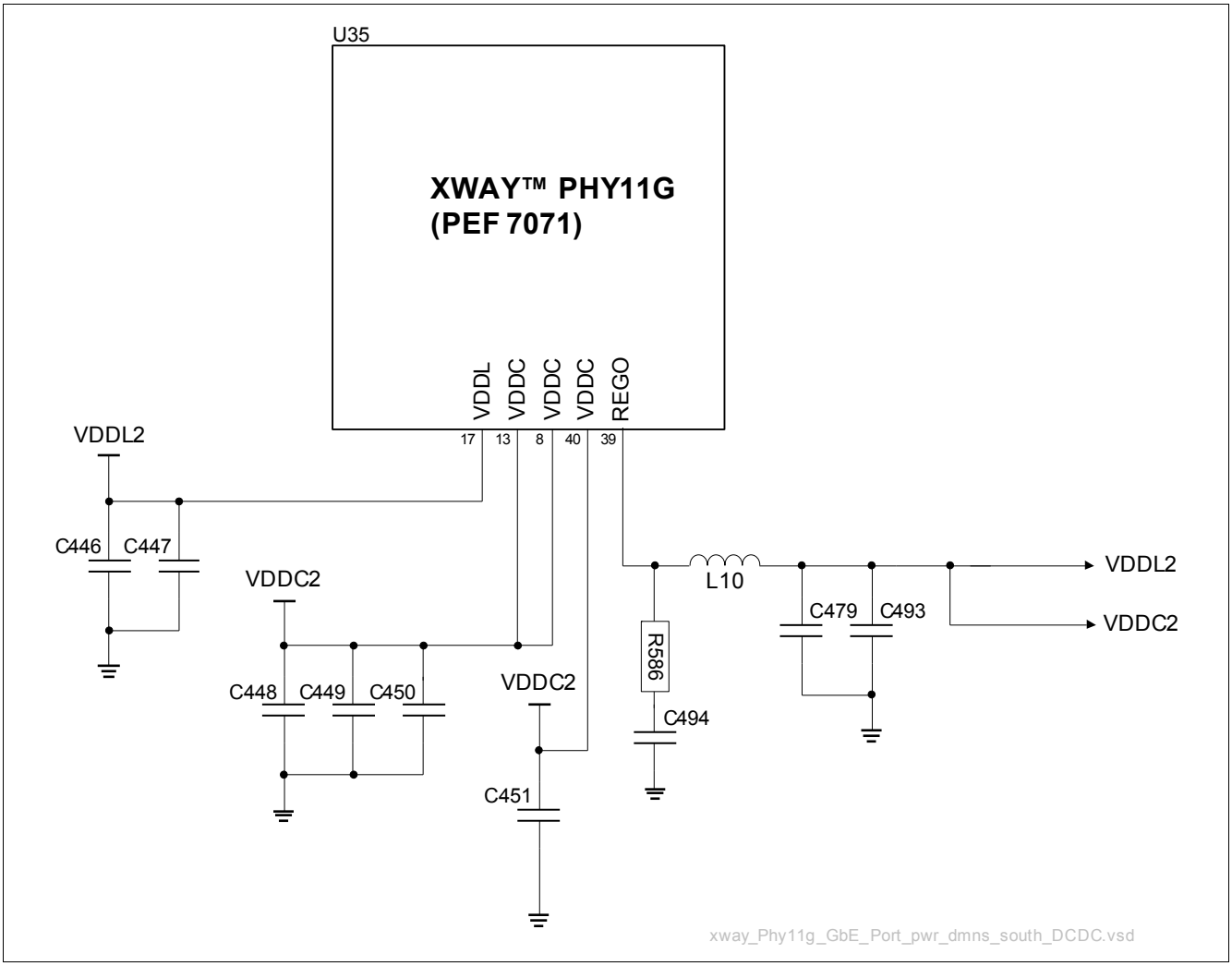

Figure 5 Provision of V_{DDC} and V_{DDL} Power Domains Using Integrated DC/DC Regulator

Figure 6 shows the option where an external power supply is used for the 1.0 V voltage domains. In this case, components R586, C494, L10, C479, and C493 are not required, but the REGO pin must be shorted to the VDDR pin.

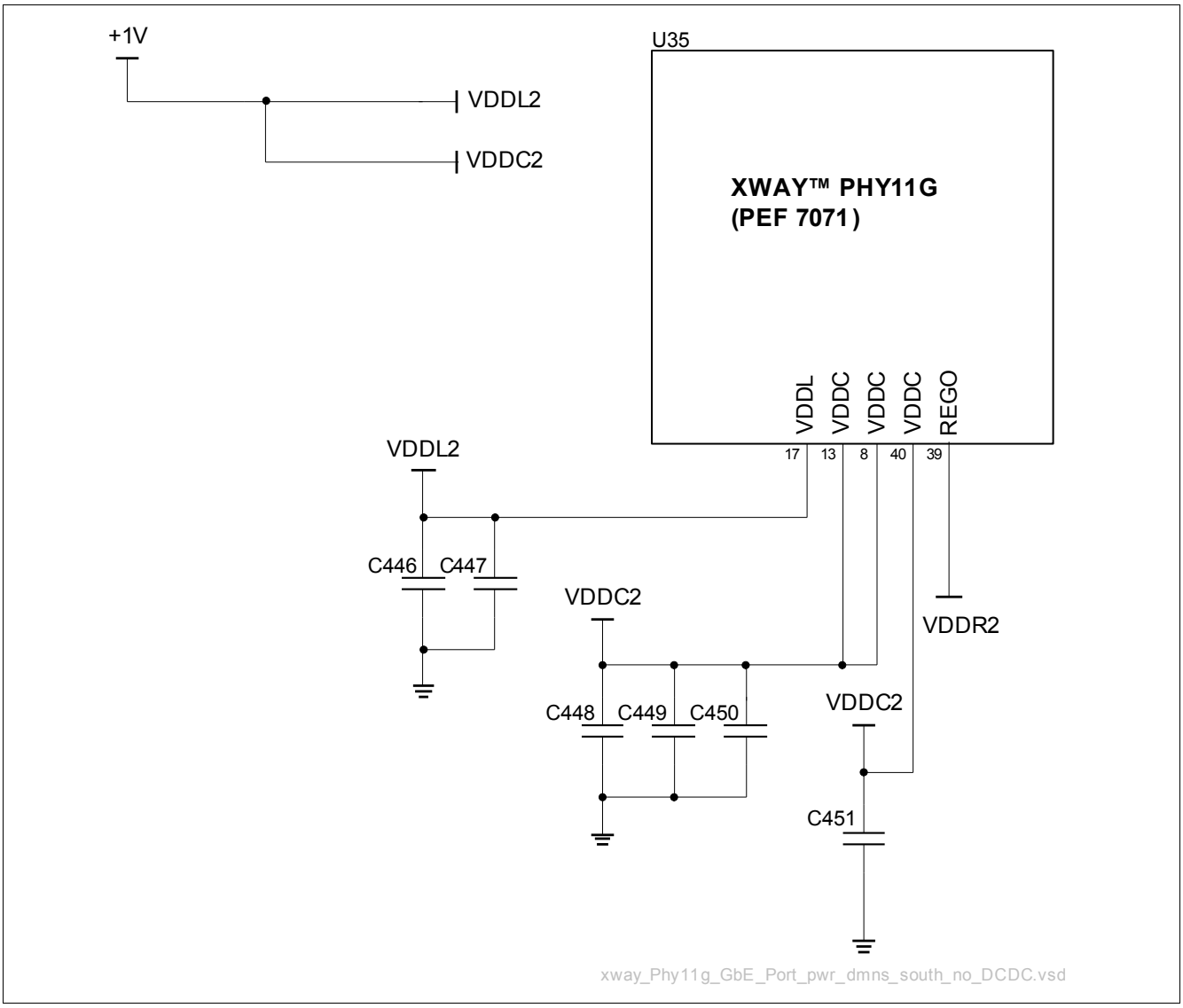

Figure 6 Provision of V_{DDC} and V_{DDL} Power Domains Using External Low-Voltage Power Supply

For details on the value and type of components required for provision of power supply domains, refer to the **Bill of Materials**.

3.4 Crystal Clock Source

A 25 MHz crystal can be used to clock the XWAY™ PHY11G. **Figure 7** shows the components required for this configuration option.

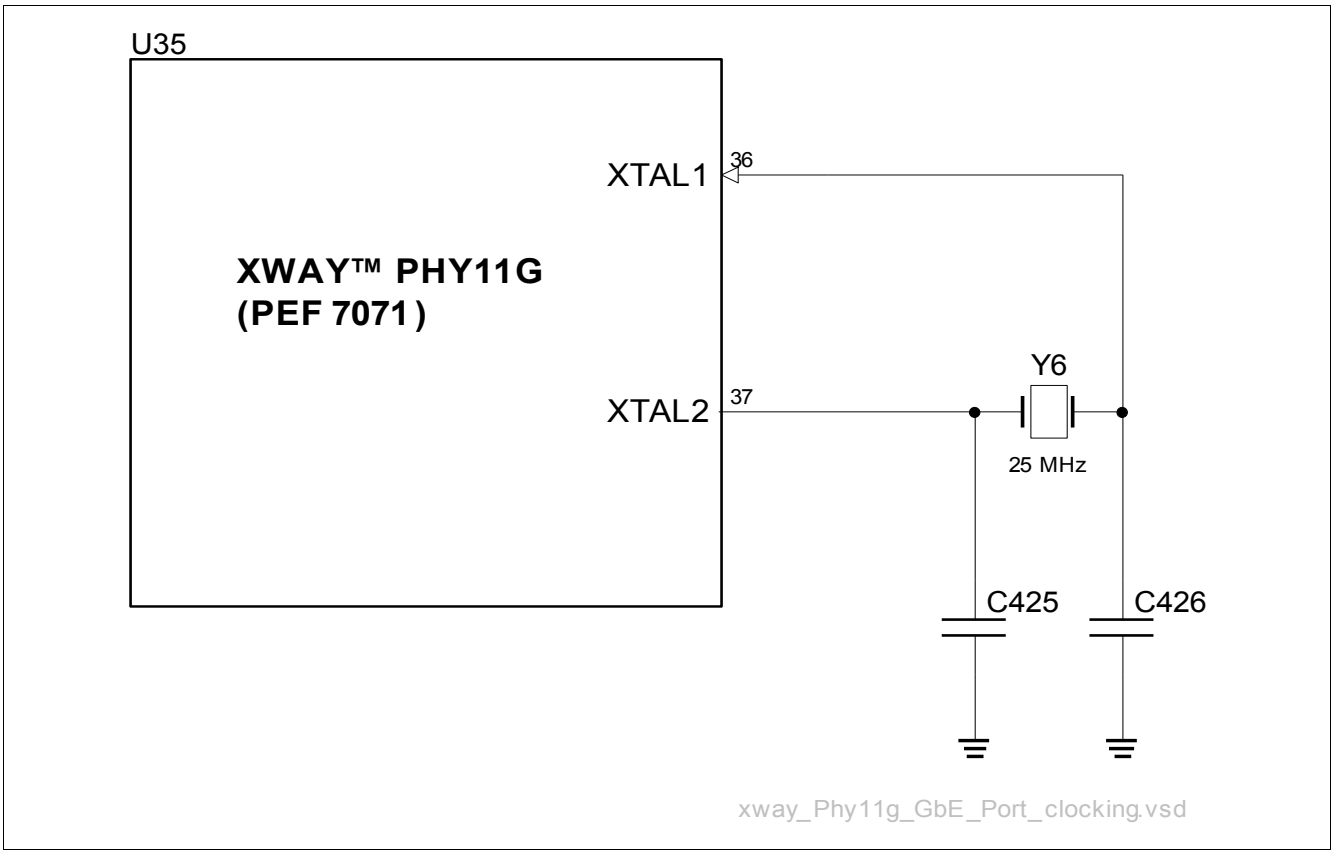

Figure 7 Circuitry for Connection of Crystal Clock

For details on the value and type of components required to connect a crystal clock, refer to the **Bill of Materials**.

4 Bill of Materials

Details of components used in the circuit are given below. The manufacturers are shown only for illustration, equivalent components may be employed.

Table 1 Bill of Materials

Component	Description	Value	Package Information	Manufacturer
C434, C438, C439, C440, C441, C442, C443, C447, C449, C450, C451	Ceramic Chip Capacitor, 16 V X7R, 10%	100 nF	c0402	TDK Corporation
C435, C436, C444, C446, C448	Ceramic Chip Capacitors, 16 V X5R, 10%	10 µF	c0805	TDK Corporation
T1	1000BASE-T LAN-Transformer	7490200136		Wurth Elektronik GmbH & Co. KG
J1	RJ45, Single Port Sheilded Connector	615008143521		Wurth Elektronik GmbH & Co. KG
LED1	SMD LED 0805 yellow	LED/0805	LED0805AC	Wurth Elektronik GmbH & Co. KG
LED2	SMD LED 0805 green	LED/0805	LED0805AC	Wurth Elektronik GmbH & Co. KG
R487, R489	Resistor, 5%, 0.1 W	150 Ω	R0603	Yageo Corporation
R514, R527, R520	Resistor, 0.625 W	11 kΩ, 1%	R0402	Yageo Corporation
R481	Chip Resistor CRCW	4.7 kΩ	R0603	Vishay Intertechnology, Inc.
R502, R503	Resistor, 0.0625 W	16 kΩ, 1%	R0402	Yageo Corporation
R584, R607	Resistor, 5%, 0.063 W	10 kΩ	R 0402	Yageo Corporation
R608	Resistor, 5%, 0.063 W	1.5 kΩ	R0402	Yageo Corporation.
RP601	Resistor, 5%, 0.06 W, Array 8P4R	68 Ω	R\8P4R\0402	Yageo Corporation
R181	Resistor, 5%, 0.063 W	33 Ω	R0402	Yageo Corporation
U35	XWAY™ PHY11G	PEF 7071	PG-VQFN-48	Lantiq
R606	Resistor, 0.0625 W	75 Ω, 1%	R0402	Yageo Corporation
C426, C425	Ceramic Chip Capacitor, 50 V NP0, 5%	33 pF	C0402	TDK Corporation
R1, R2, R3, R4	Resistor, 5%	75 Ω	R0603	Yageo Corporation
C1	Ceramic Chip Capacitor, 3 kV X7R, 10%	1 nF	C1808	Holy Stone Enterprise
C620	Electrolytic, 10 V	10 µF	Through-hole	TDK Corporation

Table 1 Bill of Materials (cont'd)

Component	Description	Value	Package Information	Manufacturer
Required components if the internal DC/DC regulator is used:				
L10	Inductor, SMD, 315 mA, ±10%, 1812 Wound	4.7 µH	L-WIC-453232F	Wurth Elektronik GmbH & Co. KG
C479, C494	Ceramic Chip Capacitor, 50 V NPO, 5%	330 pF	C0402	TDK Corporation
C493	Ceramic Chip Capacitor, 10 V Y5V, +80-20%	22 µF	C1206	TDK Corporation
R586	Resistor, 5%, 0.063 W	5.1 Ω	R0402	Yageo Corporation
Y6	DIP HC49S, 15 ppm, 20 pF	25 MHz	Crystal	TXC Co. Limited

5 List of Preferred Transformers/Modules

Here is an indicative list of transformers which have been shown to give the performance that is required of the device. It is not an exhaustive list. For the parameter values that need to be met by the transformer for optimal performance, please refer to Chapter 6 of the User's Manuals [1], [2] and [3]. The following parts have been measured and tested with our chipsets and seen with good performance.

Table 2 List of Recommended Transformers

Part No.	Type	Manufacturer
7490200136	Single 10/100/1000BASE-T	Wurth Elektronik GmbH & Co. KG.
H5004NL	Single 10/100/1000BASE-T	Pulse Corporation
LAN3241	Single 10/100/1000BASE-T	LinkCom Manufacturing Co., Ltd
LAN3482	Dual 10/100/1000BASE-T	LinkCom Manufacturing Co., Ltd

Literature References

[1] XWAY™ PHY11G (PEF 7071) Version 1.5 User's Manual Hardware Description Revision 2.0

[2] XWAY™ PHY11G (PEF 7071) Version 1.4 User's Manual Hardware Description Revision 1.0

[3] XWAY™ PHY11G (PEF 7071) Version 1.3 User's Manual Hardware Description Revision 1.5

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